CNTT-E-109

BASIC ELECTRICITY AND ELECTRONICS

STUDENT HANDOUT

NO. 202

SUMMARIES
PROGRESS CHECKS

FOR

MODULES
20 LESSONS 6&7
20T LESSON 1
21 LESSON 1

JUNE 1984

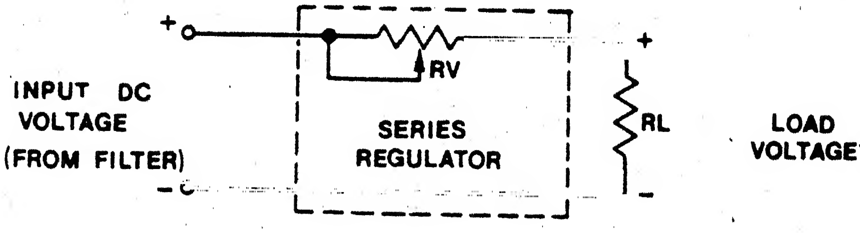
SUMMARY
LESSON VI

Power Supply Regulator Theory

A voltage regulator is the final stage in many power supplies. A voltage regulator will maintain a constant DC output voltage in spite of input AC line voltage fluctuations or output load changes.

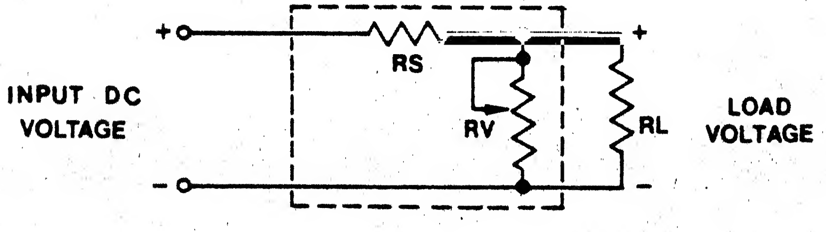
There are two classifications of voltage regulators: series regulators and shunt regulators. Regulators are classified according to the way the regulating device is connected with the load: in series or in parallel (shunt).

The simplest type of regulator is a series regulator.



In this schematic, the regulating device is represented by a variable resistor (Rv). If the input DC voltage from the filter increases, the resistance of Rv may be increased in order to maintain a constant voltage across R_L. By the same token, Rv may be decreased if input voltage decreases.

A shunt regulator has the regulating device in parallel with the load:

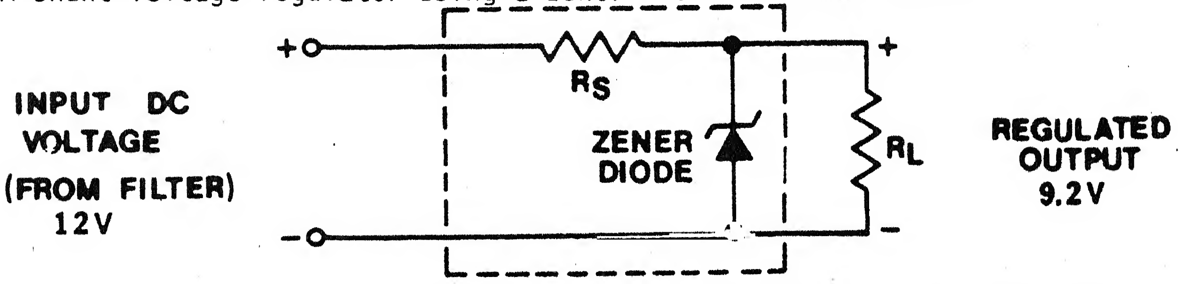


Rs is a resistor in series with the load and Rv again represents a regulating device. If the input voltage increases, it is necessary to increase the voltage drop on Rs in order to maintain a constant voltage across R_L. By decreasing the resistance of Rv, the current flow through Rv and Rs will increase and the voltage drop across Rs will increase.

If the input voltage decreases, the resistance of Rv must be increased to decrease the voltage drop across Rs to maintain a constant voltage across R_L.

Most regulators do not use variable resistors because the input voltage will fluctuate too rapidly to be controlled manually. One type of automatic regulating device is the Zener diode. A Zener diode is a special kind of diode that will maintain a constant voltage (known as Zener voltage) when biased to conduct in the reverse direction even though its current may vary over a wide range.

A shunt voltage regulator using a Zener diode is shown below:



Since the Zener diode maintains a constant load voltage, all increases and decreases in input DC voltage or variations of the load will be absorbed by the series resistor Rs.

AT THIS POINT, YOU MAY TAKE THE LESSON PROGRESS CHECK. IF YOU ANSWER ALL SELF-TEST ITEMS CORRECTLY, PROCEED TO THE NEXT LESSON. IF YOU FEEL THAT YOU HAVE FAILED TO UNDERSTAND ALL, OR MOST, OF THE LESSON, SELECT AND USE ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS (IF APPLICABLE) OR CONSULTATION WITH YOUR LEARNING CENTER INSTRUCTOR, UNTIL YOU CAN ANSWER ALL SELF-TEST ITEMS ON THE PROGRESS CHECK CORRECTLY.

PROGRESS CHECK
LESSON VI

Power Supply Regulators

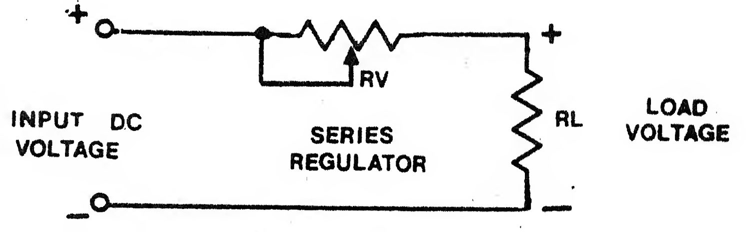
1. Describe the function of a voltage regulator:

____

____

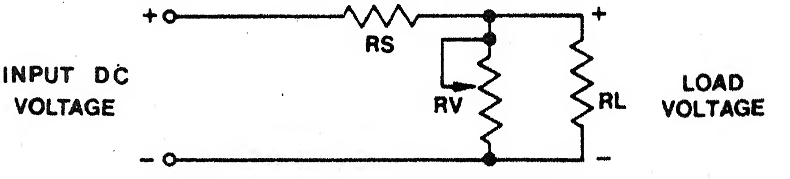
2. If the input DC voltage to the illustrated voltage regulator increases, should RV be increased or decreased to maintain a constant voltage across R_L?

____



3. If the output DC voltage of the illustrated voltage regulator decreases due to load change, should RV be increased or decreased to maintain a constant voltage across R_L?

____



4. The purpose of a Zener diode in a shunt voltage regulator is to

a. convert AC to DC voltage.
b. allow current to flow in only one direction.
c. maintain a constant DC current flow.
d. maintain a constant DC voltage.

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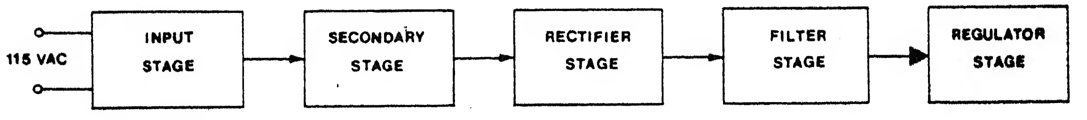
SUMMARY
LESSON VII

Power Supply System Concept

The previous six lessons dealt with the functional stages of the power supply. This lesson is designed to present a system concept of the power supply. This lesson covers the following areas:

1. The effects of loading and the importance of matching the power supply specifications to the load.

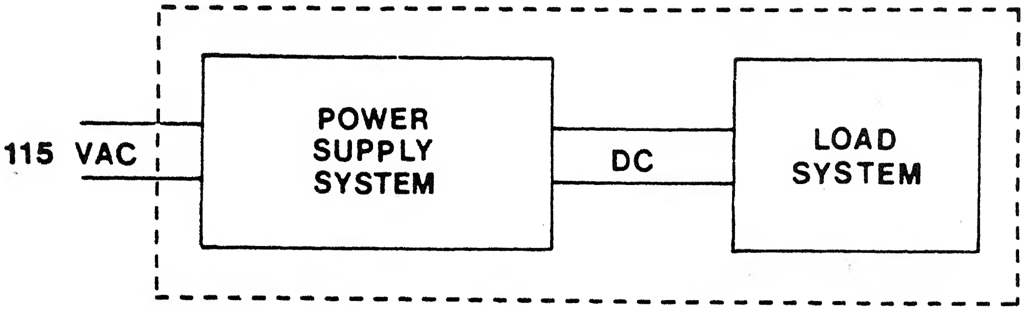
2. The effects of interstage loading in the power supply system.



POWER SUPPLY SYSTEM

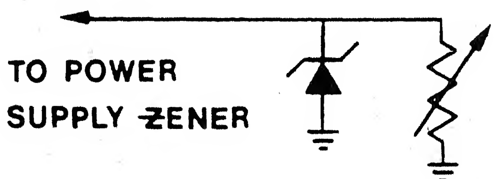
The five stages of the power supply make up a system. This system is designed to perform a specific overall function. That function is to provide the voltage and current requirements of the load. Any device or circuit connected to the power supply is called the load. As long as the power supply is matched to the load, the power supply will perform with no difficulty. If a mismatch occurs between the power supply and load, the power supply will operate much like a track star trying to run with a 200 pound weight. Not only will the power supply encounter serious problems with performance; it may also fail to hold up under the strain of the mismatch.

When a load is added to the power supply, the total impedance offered to the 115VAC changes. If the load is primarily the addition of parallel impedance the total impedance of both circuits will decrease. (Adding resistance in parallel will decrease the total resistance of all the branches). Adding a load that is mainly in series between the power supply and the original load will increase the total impedance of the network. If the load impedance increases or decreases, the amount of current drawn from the 115VAC souce will change.

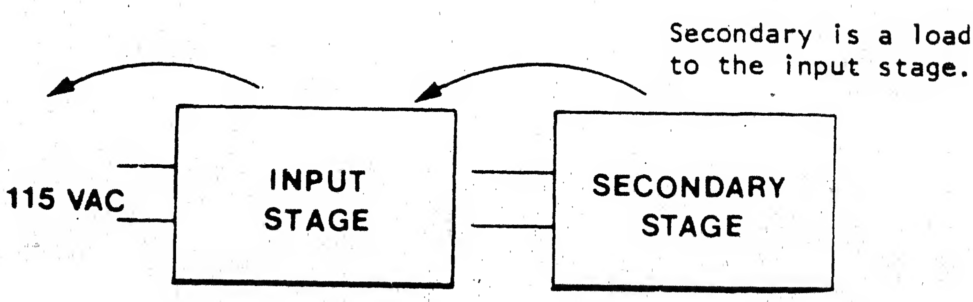


EQUIPMENT SYSTEM

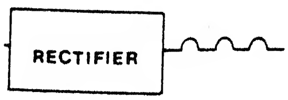
If the load attached to the power supply is fixed, it is simple to design a power supply to provide a constant voltage. The situation changes when the load is variable. Without regulation, everytime the variable load's impedance changes, the current through the entire system changes. The voltage output of the power supply will also change. By using an oscilloscope, the voltage output can be seen to change with changes in the variable load. Automatic voltage regulators correct this varying output voltage. For example, the Zener diode will pass more or less current depending on how much current is demanded by the variable load. Since current in each parallel branch is additive, total current is the sum of the current in each branch. When the variable load is reduced, more current will try to flow in the load. The Zener will adjust its internal resistance and allow less current to flow through it. Therefore, total system current remains unchanged.



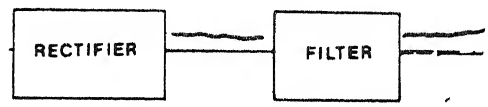
The Zener is capable of operating only within a specific range of current changes. If the load calls for more regulation than the Zener can provide, total current will start to rise; total voltage start to decrease. When this happens the power supply is said to be overloaded.



When stages are added in sequence to the 115 VAC source, total impedance changes with each addition. For instance, the input stage offers a specific amount of impedance to the 115 VAC. When the secondary stage is then added, the secondary will act like a load to the input stage. In other words, each stage added acts like a load to the previous stage or stages. When the loading effect of each stage within the power supply system is considered, it is referred to as interstage loading. The most visible interstage loading occurs when the filter is added to the rectifier. The "bumps" coming out of the rectifier are immediately changed to a ripple. The loading effect of the filter causes this change.



Without A Load



With A Filter Load

When the regulator is added to the filter, the amount of ripple in the filter increases. Without the regulator, the filter does a great job of smoothing out the "bumps" from the rectifier. The regulator load draws current through the filter and makes the filter work harder. The final result--the ripple becomes more pronounced.

So remember, each stage of the power supply has a specific function. Each separate function combines to produce the system function. One system interacts with another system (power supply + radio circuits) to provide another combined system function (receive radio broadcasts). These interlocking functions have endless combinations.

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JOB PROGRAM
FOR
LESSON VII

Power Supply Regulation and Loading Effects

REFERENCES

1. Instruction Manual, Power Supply, NIDA Trainer 201
2. Instruction Manual, Load Box, NIDA 201L

EQUIPMENT AND MATERIALS

1. NIDA 201 Power Supply
2. PC 201-2 Printed Circuit Card
3. NIDA 201L Load Box
4. 1X Probe
5. Dual Banana Plug Cable
6. Oscilloscope
7. Pre-faulted 201-2 Printed Circuit Card (Obtain in step 16)
8. Multimeter and Meter Leads

1. Using all applicable safety precautions energize and obtain a line trace on the oscilloscope. Set up the oscilloscope as follows:

   a. VOLTS/CM - 10 Volts/Cm
   b. AC-DC-GND SWITCH - DC
   c. SWEEP FREQ Hz - 100-1K

2. Set up the NIDA 201 Power Supply.

   a. Connect the NIDA 201L Power Supply using the dual banana plug cable. Ensure that all toggle switches on the Load Box are in the "down" position and the LOAD SELECTOR SWITCH is in the "lamps" position. Set the parallel - series switch in the series position.

3. Install PC 201-2 (Zener Regulator Printed Circuit Card). You now have added the Voltage Regulator, the final stage, to your power supply. Voltage regulators maintain a constant voltage output under varying load conditions. All voltage regulators have certain operating ranges. If the load varies outside the operating range of the regulator, the voltage will also vary.

4. Ensure all connections are properly made and energize the NIDA 201 Power Supply. Record the voltage and current readings on the front panel meters of the power supply.

_______________________ VDC _______________________ DC Amps

5. Set up your oscilloscope to measure DC voltage.

a. The oscilloscope can be used to measure DC as well as AC voltage. The following procedure will aid you in measuring DC voltages with an oscilloscope. You will use this method in step 6:

(1) Place the AC-DC-GND Switch to "DC".

(2) Connect the probe to IN Jack on the oscilloscope and its ground lead to convenient ground on the chassis. DO NOT ground the probe to CR1 or CR2.

(3) Establish a zero volt reference by aligning the line trace to one of the horizontal graticule lines on the face of the oscilloscope.

(4) Connect the probe to point to be measured and count the number of divisions that the line trace is displaced. (Ensure the ground lead is still attached to a chassis ground.)

(5) Multiply this number by the volts/CM setting on the VOLTS/CM Switch. The result will be the amount of DC voltage present.

(6) Any AC component of the input signal will also be displayed on the oscilloscope with the AC-DC-GND Switch in the "DC" position. The sweep reference will move up or down according to the DC voltage present and the AC signal will "ride" on (vary around) this level.

6a. Now, using your oscilloscope measure and record the output voltage of the Zener Regulator PC 201-2. (See pages 2-6 and 4-8 of NIDA Instruction Manual.) _______________________ VDC

6b. The voltage you calculated with your oscilloscope should be the same as (within ±10%) the voltages you obtained in step 4 from the front panel meters.

6c. From this you can see that you can obtain DC measurements with an oscilloscope thus proving that you do not always require a multimeter for DC measurements.

7. Now let's look at the voltage regulator and see how it operates. As you know, when you vary the load on your power supply, the regulator will compensate for the change in voltage caused by the change in load. Occasionally the load will increase to the point where the Zener can't compensate for the change in the load.

8. We will use the circuit in step 3 as a reference for the following steps.

   a. Measure and record the input voltage to the regulator card. ______________ VDC (measured with oscilloscope).

   b. Measure and record the output from the regulator. ________ VDC (TP18 on PC 201-2 - measured with oscilloscope).

   c. Calculate the voltage drop across R1 (input voltage minus output voltage). ______________ VDC.

   d. Using ohms law ($I = \frac{ER1}{R1}$), figure the current through R1. ______________ AMPS. (Refer to page 4-8 of NIDA 201 Technical Manual for the value of R1).

   e. Observe and record the load current (Read from the "DC Amperes" meter on front panel of the NIDA 201 Power Supply) ________ DC AMPS.

9. Now you know the current through R1 and the load current. From these currents, find current through the Zener.

   a. Using the formula IR1 = ICR1 + IRLoad, figure the current through CR1 ______________ DC AMPS.

10. The values you have just found will be considered as the values found in the normally loaded power supply.

11. Now watch the meters on the NIDA 201 Power Supply closely while you move the LOAD 1 TOGGLE SWITCH on the NIDA 201L Load Box to the "Load 1 and 2" position. By adding load 2 to the circuit you have varied the load.

   a. Record the voltage and current readings on the power supply meters ______________ VDC ______________ DC AMPS.

   b. Did the voltage vary appreciably from the reading taken in step 8b? ______________ .
   (yes/no)

12. Now find the values of ER1 ________ IR1 ________ and ICR1 ________ .

13. You'll notice that even though the load current increased, the current through R1 remained the same and the current through CR1 decreased. The Zener diode CR1 (increased/decreased) conduction in order to hold the output voltage constant. There was little or no change in power supply output voltage. The power supply is operating within the control range of our regulator.

14. Again, watch your meters while moving the PARALLEL-SERIES switch on the Load Box to the "PARALLEL" position.

a. Record the voltage and current readings on the Power Supply meters.
_____________ VDC _____________ DC AMPS

b. Did the voltage change from the reading taken in step 11?
_______________ (yes/no)

c. Did the current vary? _______________ (yes/no).

The relatively large change in the power supply voltage indicates that you have "overloaded" the power supply. By placing LAMPS 1 AND 2 in "PARALLEL" you have caused the load box to draw current that exceeds the operating range of the Zener regulator. The regulator can no longer keep the power supply's output voltage constant and therefore the voltage output decreases.

15. Again, by using Ohm's Law you can see what happens in an overloaded power supply. Compute the values for ER1 __________, IR1 __________, and ICR1 __________ for the overloaded power supply in step 14.

Notice that the current through series resistor R1 equals the load current, leaving a negligible current flow through Zener diode CR1. This turns the zener diode off and effectively removes it from the circuit. The power supply is unregulated when this occurs.

16. Now that you have had some practice with a "good" regulator card, let's see if you can troubleshoot a faulty regulator card.

17. De-energize 201 Power Supply, remove PC 201-2 and install the Pre-Faulted PC 201-2 Printed Circuit Card. Energize 201 Power Supply.

18. Re-do Steps 4 through 9 of this job program.

19. Use the ohmmeter to isolate the faulty component(s) and fault on the Pre-Faulted PC 201-2 Printed Circuit Card.

20. Check your findings with your Learning Center Instructor.

21. De-energize your equipment, and return all material to it's proper stowage.

CHECK YOUR RESPONSES TO THIS JOB PROGRAM WITH THE ANSWER SHEET. IF YOUR RESPONSES AGREE WITH THE ANSWER SHEET, YOU MAY TAKE THE LESSON PROGRESS CHECK. IF YOUR RESPONSES DO NOT AGREE OR IF YOU FEEL YOU HAVE FAILED TO UNDERSTAND ALL, OR MOST, OF THIS JOB PROGRAM, REVIEW THE PROCEDURES OF THIS JOB PROGRAM, ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS OR CONSULTATION WITH YOUR LEARNING CENTER INSTRUCTOR UNTIL YOUR RESPONSES DO AGREE.

PROGRESS CHECK
LESSON VII

Power Supply Systems Concept

1. In a power supply system the addition of circuits which cause the total impedance to change is called ______________________.

2. The effect that the filter has on the rectifier stage is called

____________________________________.

3. What will the addition of more circuits do to the impedance of a power supply?

____

4. a. In an unregulated power supply, what will happen to the current in a fixed branch if current changes in some other parallel branch? ____

   b. What is this effect called? ____________________________

5. What will we do to offset the effect that changing current requirements have on the output voltage? ____________________________

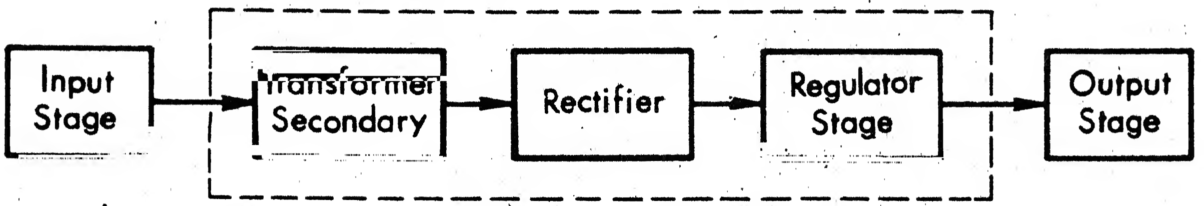
CHECK YOUR ANSWERS TO THIS PROGRESS CHECK WITH THE ANSWERS IN THE BACK OF YOUR STUDENT GUIDE. IF YOU FEEL THAT YOU HAVE FAILED TO UNDERSTAND ANY PART OF THIS LESSON YOU SHOULD CONSULT YOUR LEARNING CENTER INSTRUCTOR FOR ASSISTANCE AND REMEDIATION. IF YOU ANSWERED ALL QUESTIONS IN THE PROGRESS CHECK CORRECTLY, CONSULT YOUR LCI FOR ASSIGNMENT TO THE MODULE TEST.

SUMMARY
LESSON 1

Electron Tube Power Supplies

Transistors are rapidly replacing tubes. The big reason transistors are taking over is that transistorized circuits reduce the size and the voltage requirements of equipments. We will be discussing vacuum tubes because they still take a very active part within the Navy's electronic inventory.

CONVERSION STAGES

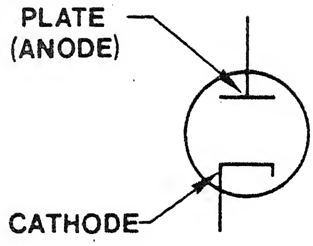


The block diagram shown above should be familiar. It is a block diagram of a basic power supply and could be either solid state or tube. The schematics are also very similar except, naturally, there will be tube symbols instead of transistor symbols. NOTE: Solid state means transistors are used.

The input circuits will be schematically identical and perform the same function. The components in a vacuum tube power supply will generally be physically larger because of higher power requirements.

The transformer secondaries in a vacuum tube power supply are usually multi-winding: step-up and step-down. The step-up winding supplies the high voltage required by the equipments while the step-down winding supplies the low voltage required by the filament or heater.

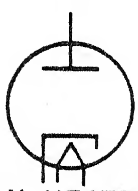
Vacuum tube rectifier circuits also use diodes. Vacuum tube diodes have two elements: a plate and a cathode.



The plate is the positive element and the cathode is the negative element. Vacuum tube diodes function the same as solid state diodes. They allow current to flow in only one direction: from cathode to plate. In order to have current flow in the vacuum tube diode the cathode must be heated to "boil off" free electrons. Heating is accomplished in one of two ways: directly or indirectly.

DIRECTLY HEATED CATHODE

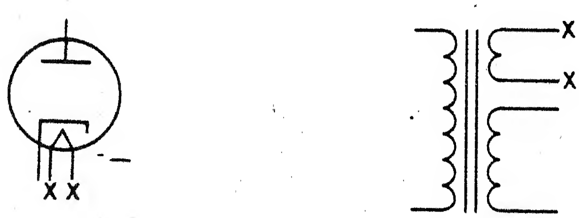
In a directly heated cathode, the heating current flows directly through the cathode. In this case, the cathode is called a filament.



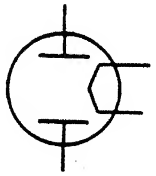
INDIRECTLY HEATED CATHODE

In an indirectly heated cathode, the heating current flows through a heater placed in close proximity to the cathode.

NOTE: Schematically the filament or heater circuits are rarely shown. When they are, you'll see the filament or heater wires chopped off with two symbols (such as X's) at the end. The X's means that somewhere on the schematic you will find two other X's that show where (usually by the transformer step-down secondary) the heater voltage originates.



Vacuum tube power supply rectifier circuits (the half-wave, the full-wave and the bridge) have output waveshapes which will be exactly identical to solid state rectifier circuit output waveforms; only the amplitude will be much higher. Of the three rectifiers, the full-wave rectifier is the most commonly used rectifier for vacuum tube circuits. The full-wave rectifier may consist of two vacuum tube diodes or one duo-diode which contains two plates and a common cathode enclosed within a single tube envelope.

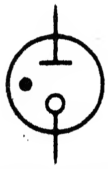


Duo-diode Schematic

The bridge rectifier, although common in solid state power supplies, is seldom used in vacuum tube power supplies because of its large size and high cost.

Filters used in vacuum tube power supplies are of the same type as used in transistor power supplies: choke input, capacitor input, and pi. Here again, the actual components in the filter circuits will be larger in size and higher in current rating because of the higher voltages they are required to handle.

The final stage of the power supply is the regulator. The solid state power supply used a Zener diode. The tube equivalent of a Zener is the VR tube (<u>V</u>oltage <u>R</u>egulator).



VR Tube Schematic

NOTE: The round dot (●) indicates that the tube is gas filled.

The VR tube, like the Zener, is connected in parallel with the load. The function of both is identical: to regulate the output.

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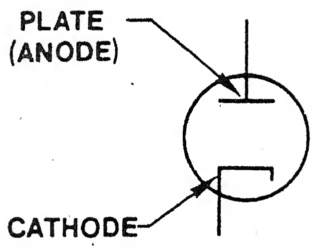

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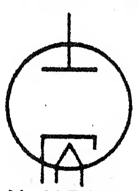

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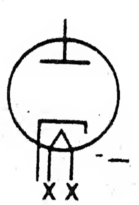

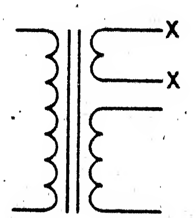

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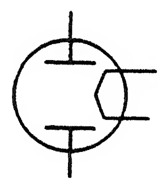

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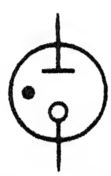

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NOTE: The round dot (●) indicates that the tube is gas filled.

The VR tube, like the Zener, is connected in parallel with the load. The function of both is identical: to regulate the output.

AT THIS POINT, YOU MAY TAKE THE LESSON PROGRESS CHECK. IF YOU ANSWER ALL SELF-TEST ITEMS CORRECTLY, PROCEED TO THE NEXT LESSON. IF YOU FEEL THAT YOU HAVE FAILED TO UNDERSTAND ALL, OR MOST, OF THE LESSON, SELECT AND USE ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS (IF APPLICABLE), OR CONSULTATION WITH YOUR LEARNING CENTER INSTRUCTOR, UNTIL YOU CAN ANSWER ALL SELF-TEST ITEMS ON THE PROGRESS CHECK CORRECTLY.

PROGRESS CHECK
LESSON I

Electron Tube Power Supplies

1. What is the basic difference and/or similarity between tube and transistorized equipment?

   a. Functionally the same, but different in size and voltage requirements.
   b. Usage and voltage requirements the same.
   c. Functionally different, but size and voltage the same.
   d. There are no differences either functionally or in size requirement.

2. The only difference, if any, between a vacuum tube power supply input circuit and a transistor power supply input circuit is that:

   a. vacuum tubes are used instead of transistors.
   b. the components are of different values or size.
   c. the transistor power supply circuit provides greater overload protection.
   d. there is no difference.

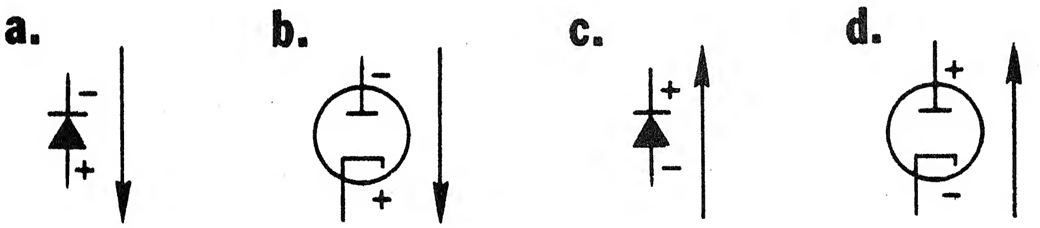
3. Which of the statements below is most correct?

   a. Transistorized power supply transformer secondaries always use step-up and tube power supply transformer secondaries can use either step-up or step-down.
   b. Transistor and tube power supply transformer secondaries can be step-up or step-down, but perform different functions in their power supply.
   c. Power supply transformer secondaries for tube power supplies are multi-lead step-up and step-down, while transistor power supply transformer secondaries are usually step-down.
   d. Tube power supply transformer secondaries use only the primary winding of a transformer to regulate the power supply output voltage.

4. Which of the statements below is most correct?

   a. Tube rectifiers are usually configured as bridge rectifiers whereas transistor rectifiers are usually configured as half-wave rectifiers.
   b. Transistor rectifiers use larger components than tube rectifiers.
   c. Tube rectifiers and transistor rectifiers function the same.
   d. Tube rectifiers rectify current while transistor rectifiers rectify voltage.

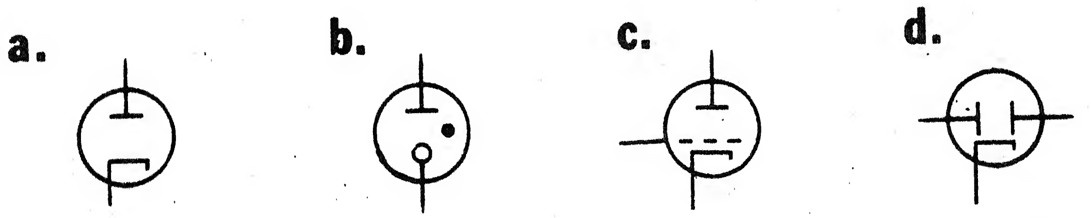
5. Which of the schematic symbols illustrated below indicates correct current flow for a tube diode?



6. Tube power supply filter networks, as compared to transistor power supply filter networks, are

   a. smaller in size, but function the same.
   b. larger in size, but function the same.
   c. identical in function and size.
   d. configured differently and function differently.

7. Which of the tube schematic symbols illustrated below is comparable to a Zener diode regulator?



8. What is the major functional difference, if any, between Zener diode regulators and voltage regulator tubes?

   a. There is no functional difference.
   b. Voltage regulator tubes regulate AC voltage, while Zener diodes regulate DC voltage.
   c. Zener diodes regulate AC voltage, while voltage regulator tubes regulate DC voltage.
   d. Zener diode regulators can be interchanged with voltage regulator tubes.

9. Comparing a basic tube power supply to a basic transistor power supply, which of the following statements is most correct?

a. Tube power supplies are smaller than transistor power supplies and have completely different functions than transistor power supplies.
b. Tube power supplies function the same as transistorized power supplies but differ physically.
c. Tube power supplies are larger than transistor power supplies and have completely different functions than transistor power supplies.
d. Tube power supplies have no similarity with transistorized power supplies.

CHECK YOUR ANSWERS TO THIS PROGRESS CHECK WITH THE ANSWERS IN THE BACK OF YOUR STUDENT GUIDE. IF YOU FEEL THAT YOU HAVE FAILED TO UNDERSTAND ANY PART OF THIS LESSON YOU SHOULD CONSULT YOUR LEARNING CENTER INSTRUCTOR FOR ASSISTANCE AND REMEDIATION. IF YOU ANSWERED ALL QUESTIONS IN THE PROGRESS CHECK CORRECTLY, CONSULT YOUR LCI FOR ASSIGNMENT TO THE MODULE TEST.

SUMMARY
LESSON I

Basic Transistor Theory

Transistors were invented at Bell Telephone Laboratories in 1948, and have practically replaced tubes in modern electronic equipment.

Functionally, the transistor can be compared to a variable resistor because it is able to vary the current through the circuit it is in. (The transistor is a current amplifying device.) Because we are mostly concerned with current, when using transistors we speak of a transistor's conductivity.

Transistor action is similar to a variable resistor in a series regulator circuit. Increasing the resistance decreases the current through the variable resistor but increases the voltage across the variable resistor. The transistor, in essence, does the same thing. As its conductivity increases, the voltage across the transistor decreases.

A circuit will normally show the tie point between the circuit and its power source as a line, a line with an arrowhead, or a line with a dot with a +, -, Vcc, -Vcc, or a letter of the alphabet (See Figure 1).

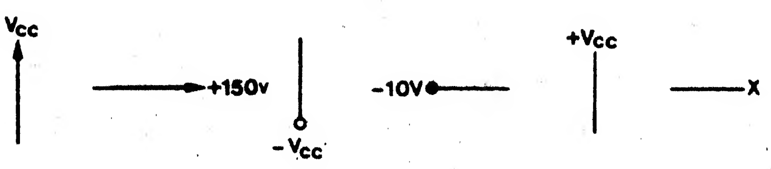
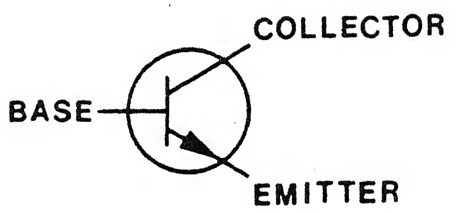


Figure 1

As shown in Figure 1, the line can be up, down, or on its side, but will always indicate a tie point between circuit and power supply.

Summary

The basic transistor is comprised of three elements: the emitter, the base, and the collector. Schematically, the transistor looks like the illustration in Figure 2.



Transistor Elements

Figure 2

There are two types of three element transistors, NPN and PNP. The NPN will have the arrow on the emitter NOT POINTED IN. The PNP will have the arrow POINTED IN from the PERIMETER. NPN transistors will be used mainly with positive power supplies, and PNP transistors will be used with negative power supplies. In either case the direction of current flow will always be against the arrow. See Figure 3.

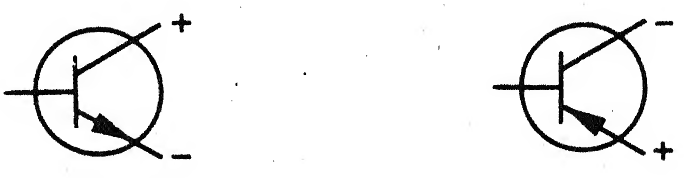
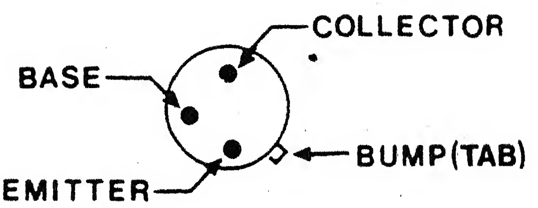


Figure 3

Transistor elements can be easily identified by some key or mark that will be placed on it by the manufacturer. This key or mark will almost always be nearest to the emitter. See Figure 4.



Transistor Lead Identification

Figure 4

Figure 4 shows the underside of a common transistor. The small bump identifies the emitter and, going clockwise, we have the base, then the collector. Other base diagrams and transistor data are given in reference books such as Electronics Information Maintenance Bulletin, transistor manuals, and equipment technical manuals.

AT THIS POINT, YOU MAY PROCEED TO THE JOB PROGRAM. IF YOU FEEL THAT YOU HAVE FAILED TO UNDERSTAND ALL, OR MOST, OF THIS LESSON, SELECT AND USE ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS (IF APPLICABLE), OR CONSULTATION WITH YOUR LEARNING CENTER INSTRUCTOR, UNTIL YOU UNDERSTAND THE MATERIAL IN THIS LESSON.

JOB PROGRAM
FOR
LESSON I

Transistor Identification

INTRODUCTION

Many times you will be required to determine whether a transistor is good or bad. Sometimes you must decide this after the transistor has been removed from the equipment. To do this you take front-to-back ratios the same way you did for diodes, but there are six measurements for a transistor instead of the two for diodes. You will also determine what type of transistor you have (NPN or PNP).

NOTE: This type of check will only indicate if the transistor is open or shorted. If a transistor checks good using this method and the device is still suspect, other methods of testing must be used.

When you use the multimeter to measure the resistance of a diode or transistor, the meter supplies the current that flows through the component being tested. Since the black (common) lead of most multimeters is negative and the red lead is positive when used for resistance measurement, you can predetermine whether the reading should be large or small for a particular type of transistor.

NOTE: The polarity of the leads on a Simpson 260 VOM can be changed with the use of the + and - DC switch. With the switch in -DC position the red lead will be negative and vice versa.

By knowing the meter lead polarities and the transistor elements (emitter, base, collector) you can determine what type of transistor (PNP or NPN) you have, providing the transistor is good. To do this you take two readings, reversing the meter leads between the emitter and base leads. The smaller of the readings indicates that the emitter to base portion of the transistor is forward biased with this polarity of voltage applied.

21.1.42.1.7 IDENTIFY the collector, base and emitter leads on an actual transistor, given a transistor and a job program. 100% accuracy is required.

EQUIPMENT AND MATERIALS

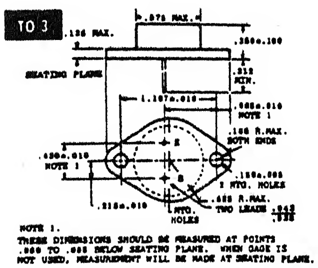
1. Multimeter Simpson 260.
2. Parts Identification board.

PROCEDURES

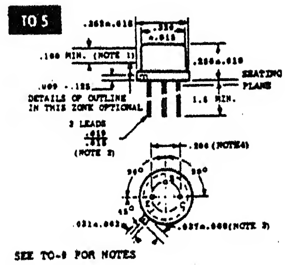
1. Components 30, 31, 32, 33 and 34 are all transistors. Technical drawings of these transistors are shown in Figure 1. From these drawings you can determine physical dimensions, identification and placement of the elements (leads), and the shape of container (TO2, TO3 etc.) in which the transistor is packaged.

1. Closely study the drawings in Figure 1 and compare them with the components mounted on the board. Then, label each drawing with the component number.

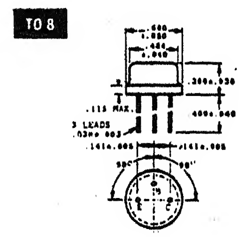
a. _____



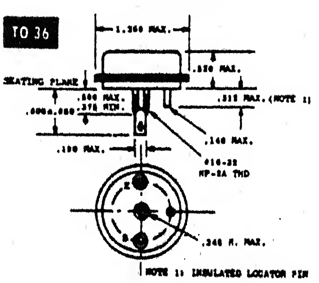
b. _____



c. _____



d. _____



e. _____

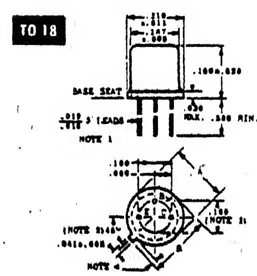


Figure 1

CHECK YOUR ANSWERS AGAINST THOSE IN THE BACK OF THIS BOOK BEFORE PROCEEDING.

Set the Simpson 260 multimeter to the RX100 scale. Set the POLARITY switch to the +DC position. While holding the leads together, zero the meter.

NOTE: Some transistors cannot handle the current provided by the multimeter on the RX1 and RX10 scales. Therefore, when checking transistors with a multimeter you should not use scales lower than RX100, for fear of damaging the transistor.

In the following chart you will determine what type of transistor you are checking. In the column labeled "Transistor Number" write the number (2NXXXX) found on the transistor that corresponds to each component number. Sometimes you may find a number other than a 2N number. It will be used for the same purpose -- transistor identification. The next three columns are labeled EB (emitter-base), BC (base-collector), and EC (emitter-collector). Below the column identification there are two sets of letters PN and NP. These letters represent polarities of the multimeter, "P" for positive and "N" for negative.

2.

Component Number	Transistor Number	EB	BC	EBC
30.		PN ____ NP ____	NP ____ PN ____	____
31.		PN ____ NP ____	NP ____ PN ____	____
32.		PN ____ NP ____	NP ____ PN ____	____
33.		PN ____ NP ____	NP ____ PN ____	____
34.		PN ____ NP ____	NP ____ PN ____	____

Let's work the first transistor together, then you can proceed on your own. In the first column (labeled EB), the first space has PN next to it. Place the red (positive) meter lead on the emitter and the black (negative) lead on the base. Record your resistive reading in the space next to the PN. Below this is the NP space; place the negative lead on the emitter and the positive lead on the base. Record this reading next to NP.

NOTE: Using the RX100 scale your multimeter may not appear to move. Record your resistance reading to the closest Kohm.

For the next column (labeled BC) do the same thing. First put the negative lead on the base and the positive lead on the collector. Record your reading. Then reverse your leads with the positive on the base and the negative on the collector. Record your reading. You have made a complete front to back ratio check on a transistor.

Do the same for the remaining transistors. When you have completed all the readings, proceed as follows.

You should have one low and one high resistive reading in the EB and BC columns, for each transistor. If you haven't, recheck that transistor.

The emitter-to-collector readings are not necessary in determining the type of transistor (PNP/NPN).

From the EB and BC columns select the PN or NP letters that gave you the lowest resistance readings. Place these in the EBC (emitter, base, collector) column. First from the EB, then from the BC. The two middle letters should be the same; use this letter only once to give you a total of three letters (NPN or PNP). Does this group of letters look familiar? Even though your letters stand for the polarity that gave you the lowest resistance reading (or, using Ohm's law, the highest current through the transistor), the type of transistor, NPN or PNP, will have the same group of letters.

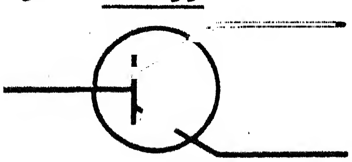
You may now return to your carrel to complete this job program using the information you have collected.

3. Using the incomplete schematic symbols below:

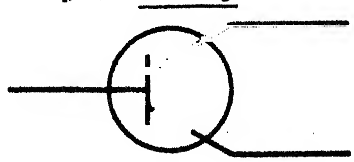
   a. Label the transistor symbol leads B (base), E (emitter), and C (collector).

   b. Draw an arrow pointing in the proper direction on the emitter lead of the transistor symbol.

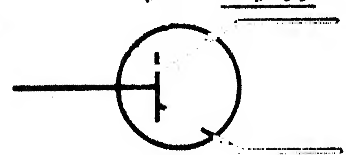
30. 2N1893



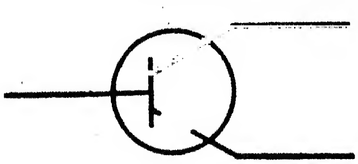
31. 2N1183



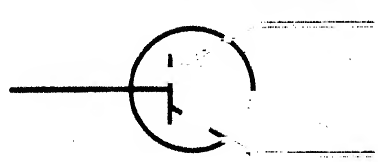
32. 2N3055



33. 2N2222A



34. ECG105

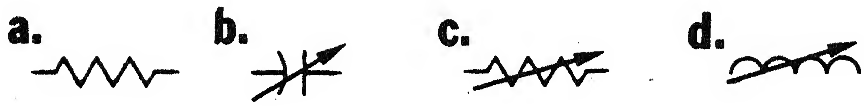


CHECK YOUR RESPONSES TO THIS JOB PROGRAM WITH THE ANSWER SHEET. IF YOUR RESPONSES AGREE WITH THE ANSWER SHEET, YOU MAY TAKE THE LESSON PROGRESS CHECK. IF YOUR RESPONSES DO NOT AGREE OR IF YOU FEEL YOU HAVE FAILED TO UNDERSTAND ALL, OR MOST, OF THIS JOB PROGRAM, REVIEW THE PROCEDURES OF THIS JOB PROGRAM, ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS OR CONSULTATION WITH YOUR LEARNING CENTER INSTRUCTOR UNTIL YOUR RESPONSES DO AGREE.

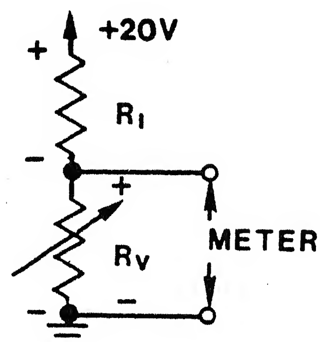
PROGRESS CHECK
LESSON 1

Basic Transistor Theory

1. Which of the following components is a functional equivalent of a transistor?



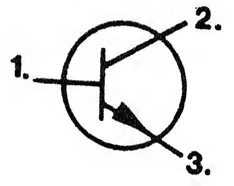
2. When Rv is increased, what happens to the voltage across Rv and the current through Rv? ______________________



3. What happens if a transistor's resistance is increased?

a. Conduction is increased and voltage across the transistor is increased.
b. Conduction is decreased and voltage across the transistor is increased.
c. Conduction is decreased and voltage across the transistor is decreased.
d. Conduction is increased and voltage across the transistor is decreased.

4. Match the correct element names to the numbers on the schematic illustration shown.



1. ______
2. ______
3. ______

a. Emitter
b. Base
c. Collector

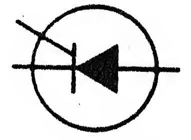
5. The element identification mark on the base of a transistor will

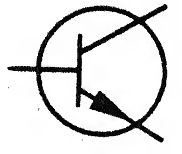
a. always be nearest the collector.
b. tell you which type it is.
c. always be nearest the emitter.
d. always be nearest the base.

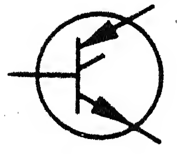
6. Which of the following symbols represents an NPN transistor and which represents a PNP transistor?

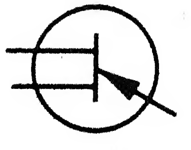
______ is NPN

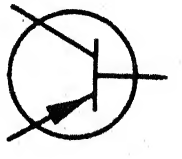
______ is PNP

1. 

2. 

3. 

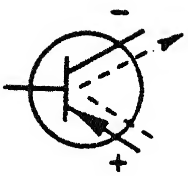
4. 

5. 

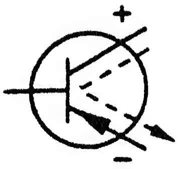
Progress Check

7. Which of the following illustrate(s) the major current flow through a transistor?

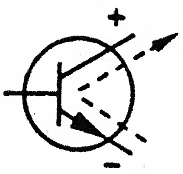
a.



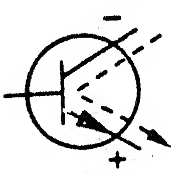
c.



b.



d.



CHECK YOUR RESPONSES TO THIS PROGRESS CHECK WITH THE ANSWER SHEET. IF YOU ANSWER ALL SELF-TEST ITEMS CORRECTLY, PROCEED TO THE NEXT LESSON. IF YOU FEEL YOU HAVE FAILED TO UNDERSTAND ALL, OR MOST, OF THE LESSON, SELECT AND USE ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS (IF APPLICABLE), OR CONSULTATION WITH YOUR LEARNING CENTER INSTRUCTOR, UNTIL YOU CAN ANSWER ALL SELF-TEST ITEMS ON THE PROGRESS CHECK CORRECTLY.

ANSWER SHEET
FOR
PROGRESS CHECKS
LESSON VI

Power Supply Regulators

QUESTION NO.	CORRECT ANSWER
1	Maintain constant voltage out regardless of current load
2	Increase
3	Increase
4	d

A.S. (J.P.)

ANSWER SHEET FOR JOB PROGRAM LESSON VII

Power Supply Output Stage

4. 27 VDC ± 10%   .06 DC AMPS ± 10%

6a. 27 VDC ± 10%

8a. 40 VDC ± 10%

8b. 27 VDC ± 10%

8c. 13 VDC ± 10%

8d. .13 DC AMPS ± 10%

8e. .06 DC AMPS ± 10%

9a. .07 DC AMPS ± 10%

11a. 27 VDC ± 10%; .08 DC AMPS ± 10%

11b. No

12. ER1 13 VDC IR1 .13 DC AMPS ICR1 .05 DC AMPS

13. decreased

14a. 21.5 VDC ± 10%; .185 DC AMPS ± 10%

14b. yes

14c. yes

15. ER1 18.5 DCV ± 10% IR1 .185 DC AMPS ± 10% ICR1 0 DC AMPS

NOTE: Tolerance of the DC AMPERES meter may give an erroneous reading of as much as 50 milliamps. If on step 15 ICR1 has up to 50 milliamps through it, it can be attributed to "slope" in the DC AMPERES meter.

ANSWER SHEET
FOR
PROGRESS CHECKS
LESSON VII

Power Supply Systems Concept

QUESTION NO.	CORRECT ANSWER
1	Loading effect (or just "loading")
2	Interloading
3	Increase or decrease
4a	Current in fixed branch will change
4b	Loading effect
5	Add a regulator or zener diode

ANSWER SHEET
FOR
PROGRESS CHECKS
LESSON 1

Electron Tube Power Supplies

QUESTION NO.	CORRECT ANSWER
1	a
2	b
3	c
4	c
5	d
6	b
7	b
8	a
9	b

ANSWER SHEET FOR JOB PROGRAM LESSON I

Transistor Identification

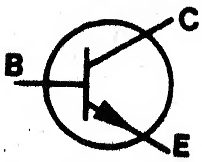
1. a. 32
   b. 30
   c. 31
   d. 34
   e. 33

2.

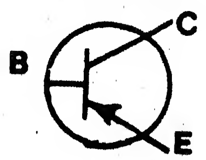
COMPONENT NUMBER	TRANSISTOR NUMBER	E-B	B-C	EBC
30.	2N1893	PN High	NP High	NPN
		NP Low	PN Low	
31.	2N1183	PN Low	NP Low	PNP
		NP High	PN High	
32.	2N3055	PN High	NP High	NPN
		NP Low	PN Low	
33.	2N2222A	PN High	NP High	NPN
		NP Low	PN Low	
34.	ECG105	PN Low	NP Low	PNP
		NP High	PN High	

*Note: Directions must be followed exactly to obtain readings as given.

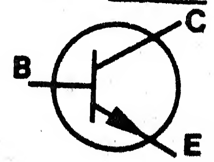
3. 30. 2N1893



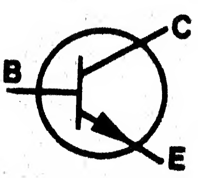
31. 2N1183



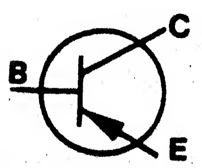
32. 2N3055



33. 2N2222A



34. ECG105



ANSWER SHEET
FOR
PROGRESS CHECKS
LESSON 1

Basic Transistor Theory

QUESTION NO.	CORRECT ANSWER
1	c
2	The voltage across Rv increases The current through Rv decreases
3	b
4.1	b
.2	c
.3	a
5	c
6	2-NPN 5 PNP
7	b

NOTES

NOTES

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